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DRAWINGS ATTACHED

1 241 604

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(54) A LIGHT DEFLECTION DEVICE

71) We, PHILIPS ELECTRONIC AND ASSOCIATED INDUSTRIES LIMITED, of Abacus House, 33 Gutter Lane, London, E.C.2, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a light deflection device having an improved combination of doubly refracting sequentially arranged prisms, for use in a digital light deflecting system.

Combinations of doubly refracting sequentially arranged prisms have been proposed hitherto for various purposes. It is furthermore known that by virtue of the laws of refraction the angular aberration of a prism has two aspects. In the first place, with a constant angle of incidence the value of the deviation is less in proportion to the refracting angle according as the latter increases (so-called refracting-angle aberration). In the second place, with a constant refracting angle, the value of the deviation increases with the departure of the angle of incidence from that angle of incidence for which a light ray passes symmetrically through the prism (so-called incident-angle aberration).

It is desirable that prisms of doubly refracting materials for use in digital light reflection systems, should exhibit a high degree of correction for angular aberration in some applications. As long as the refracting angles of such prisms are small, the two kinds of angular aberration are in general so small that single prisms are sufficient. However, if prisms having larger refracting angles are required, it may be necessary to reduce the angular aberrations involved by using an assembly of prisms.

It should be noted that a digital light deflection system is formed by a sequence in which doubly refracting prisms are alternated with polarization switches. By actuating these polarization switches a suitably plane-polarized light beam can be deflected in a direction selected from a given number of directions. In some uses of a digital light deflection system it is necessary that the selectable directions should exhibit the same relative angular distances within predetermined error limits. This requirement implies that the incident-angle aberration of doubly refracting prisms should not exceed a predetermined value. A constant incident-angle aberration might be allowed, since its effect would be identical with that of a lens so that it could be corrected by known means. A refracting-angle aberration can be corrected by a suitable choice of the refracting angle insofar as this is possible, for example, from the manufacturing point of view.

For solving this problem a prism structure comprising sequentially arranged prisms having different refracting-angles has been proposed, in which the angular aberrations occurring in single prisms can be reduced.

An object of the invention is to provide a further improved correction of the angular aberrations of a digital light deflection system by the use of a smaller number of prism elements.

According to the invention there is provided a light deflection device including the combination of an assembly comprising an even number of doubly refracting sequentially arranged prisms having equal refracting angles with an associated polarisation switch, adapted to be arranged in the path of a plane polarised beam of light, said prisms being arranged so that the refracting angles are turned in regular order of succession through 180° relatively to each other about the axis of said combination, that for each refracting face of one prism which is inclined to said axis a corresponding refracting face of another prism is oppositely inclined to said axis at substantially the same angle, and that a suitably polarised beam of light directed along said axis will traverse the component prisms alternately as an or-

[*Price 25p*]

dinary and an extraordinary ray, the arrangement being such that the magnitudes of the refracting-angle and incident-angle aberrations produced by said assembly are substantially reduced by comparison with those produced by a single doubly refracting prism providing the same range of beam deflection.

In order that the invention may be clearly understood and readily carried into effect, embodiments thereof will now be described by way of example with reference to the drawing, in which:—

Figure 1 shows an assembly consisting of two right-angled prisms,

Figure 2 shows an assembly consisting of two acute-angled prisms,

Figure 3 shows an assembly consisting of four right-angled prisms and

Figure 4 shows an assembly consisting of four acute-angled prisms.

A light deflection device is formed in conventional manner by the combination of an assembly of doubly refracting prisms with an associated polarization switch as hereinbefore described. In a first embodiment of the invention the prism assembly is of the form shown in Figure 1 in which the plane of incidence e_1 of the first prism P_1 is at right angles to the axis of the system. As is shown in the Figure, the optic axis O_1 of this crystal is at right angles to the refracting edge and at right angles to the axis of the system. The face of incidence e_2 of the second prism P_2 is parallel to that of the first prism, but the prism is turned upside down, which means that its refracting-angle $\gamma/2$ is turned through 180° about the axis of the system with respect to that of the first prism P_1. The direction of the optic axis O_2 of the prism P_2 is at right angles to that of the first prism P_1. The "free" space f between the prisms P_1 and P_2 is filled with a homogeneous isotropic material the refractive index of which is preferably the arithmetic average of the refractive indices of the doubly refracting material.

Figure 2 shows a further embodiment of the prism according to the invention. This embodiment is distinguished from the former in that the face of incidence e_1 and the face of incidence e_2 of the prisms P_1 and P_2 respectively are equally inclined to the axis of the system instead of being normal thereto, i.e. acute-angled prisms are used. The angles of inclination of all faces are equal to each other.

The prisms according to the invention are better than the constructions hitherto known, since a prism of the kind shown in Figure 1 or one of the kind shown in Figure 2 has a considerably smaller incident-angle aberration, whilst, in addition, a prism as shown in Figure 1 exhibits a particularly small difference between the incident-angle aberration of ordinary and of extraordinary rays, whilst a prism as shown in Figure 2 has a particularly small refracting-angle aberration.

The aberrations may be further reduced by using more than two component prisms. Although the use of three component prisms will further reduce the refracting-angle aberration — such a combination would have a smaller refracting-angle aberration than the known combination of Soref and MacMahon — an improvement of the incident-angle aberration is obtained only by using four component prisms. Two embodiments thereof are shown in Figures 3 and 4. The four prisms P_1 to P_4, each having a refracting angle $\gamma/4$, are arranged one behind the other, the optic axes O_1 to O_4 being turned each through 90° with respect to the adjacent axes.

The invention is not restricted to the case in which the optic axes are orientated as is shown in Figures 1 to 4. Provided that the optic axes of a prism structure are normal to each other and are lying in parallel planes, these axes may also be turned together about the axis of the system whilst maintaining the correction or improvement of the angular aberrations, and can be at an angle of 45° to the corresponding refracting edge.

WHAT WE CLAIM IS:—

1. A light deflection device including the combination of an assembly comprising an even number of doubly refracting sequentially arranged prisms having equal refracting angles with an associated polarisation switch, adapted to be arranged in the path of a plane polarised beam of light, said prisms being arranged so that the refracting angles are turned in regular order of succession through 180° relatively to each other about the axis of said combination, that for each refracting face of one prism which is inclined to said axis a corresponding refracting face of another prism is oppositely inclined to said axis at substantially the same angle, and that a suitably polarised beam of light directed along said axis will traverse the component prisms alternately as an ordinary and an extraordinary ray, the arrangement being such that the magnitudes of the refracting-angle and incident-angle aberrations produced by said assembly are substantially reduced by comparison with those produced by a single doubly refracting prism providing the same range of beam deflection.

2. A device as claimed in Claim 1, in which the optic axes of the component prisms are normal or substantially normal to the axis of the combination.

3. A device as claimed in Claim 2, in which the optic axes of the component prisms are at an angle of 45° to their refracting edges.

4. A device as claimed in Claim 2, in which the optic axes of the component prisms are parallel or normal respectively to their refracting edges.

5. A device as claimed in any one of the preceding Claims, in which the assembly of prisms is accommodated in an isotropic, homogeneous medium whose refractive index is substantially the arithmetic mean of the refractive indices of the component prisms for the ordinary and extraordinary ray.

6. Digital light deflection apparatus including a device as claimed in any one of the preceding Claims.

7. A light deflection device including the combination of an assembly comprising an even number of doubly refracting sequentially arranged prisms having equal refracting angles with an associated polarisation switch, adapted to be arranged in the path of a plane polarised beam of light, substantially as herein described with reference to the accompanying drawings.

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1241604 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

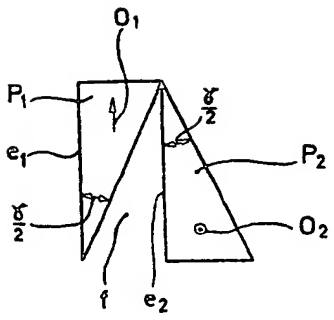

fig.1

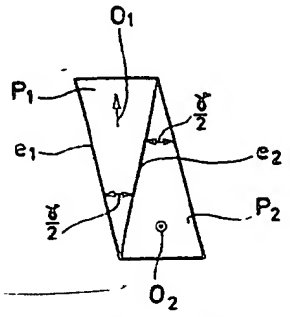

fig.2

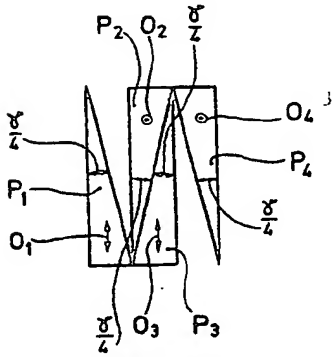

fig.3

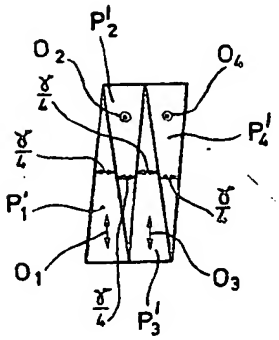

fig.4